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STUDIES OF DISTRIBUTED PRACTICE: XI. AN ATTEMPT TO RESOLVE CONFLICTING FACTS ON RETENTION OF SERIAL NONSENSE LISTS

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In 1940 Hovland (3) published a report in which retention of serial nonsense lists was measured after 2 min., 10 min., and 24 hr. In one case lists were learned by massed practice (6-sec. intertrial interval) and in another by distributed practice (2-min. intertrial interval). The results clearly showed that retention as measured by both recall and relearning was better following distributed practice than following massed practice. We have reported a similar experiment (5) in which retention after 24 hr. was much better following massed practice than following distributed practice. Since the two studies are in direct conflict, it is important that attempts be made to determine the source of this conflict.

The most apparent difference between Hovland's experiment and ours was the difference in length of intertrial rests defining distributed practice. The longest intertrial rest we used was 1 min., as compared with the 2-min. interval used by Hovland. Consequently, in one of the experiments to be reported we have used 60, 90, and 120 sec. as intertrial rests. If length of rest interval is the critical difference between the two studies, we would expect sharp increments in retention between 60 and 120 sec.

The second experiment to be reported here extends the retention interval to 48 hr. In Hovland's experiment and in our previous experiment the maximum retention interval was 24 hr. It is conceivable that retention differences following massed and distributed practice increase or decrease as the retention interval increases and that these changes are related to length of intertrial interval defining distributed practice. In the second experiment, therefore, we have used intertrial intervals in learning of 2, 60, and 120 sec. with a 48-hr. retention interval. Both experiments may be compared roughly with our previous study in which the intertrial intervals were 2, 30, and 60 sec., and the retention interval 24 hr.

PROCEDURE

General.—Each experiment consisted of three experimental conditions and one practice session. In Exp. I the only difference among conditions was length of intertrial rest during learning, these three intervals being 60, 90, and 120 sec. In Exp. II the intervals were 2, 60, and 120 sec. In Exp. I the retention interval was 24 hr.; in Exp. II, 48 hr. Original learning was always carried to one perfect recitation. Relearning was by massed practice regardless of interval used during learning and the criterion of relearning was one perfect trial.

Lists.—Each list consisted of 14 nonsense syllables having association values of 46.67% to 53.33% as calibrated by Glaze (2). Since the first syllable in a list was used only as an anticipatory cue, *S* actually learned only 13 items. The lists were constructed to have high intralist similarity. These lists are reproduced in a previous report (5) along with the rules used in constructing them. They were presented on Hull-type drums at a 2-sec. rate with learning taking place by the anticipation method.

[1] E. J. Archer supervised the gathering of the data; Jack Richardson is largely responsible for the statistical analysis.

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Specific conditions.—On the practice day *S* first learned the practice list to seven correct responses on a single trial by massed practice. Instructions were then given for the activity used to fill intertrial rests. This activity, symbol cancellation, has been described in detail elsewhere (4). Following these instructions, *S* continued learning to one perfect trial with 30 sec. between each trial. Five minutes following original learning the practice list was recalled and relearned. On the first experimental day *S* learned an experimental list to one perfect trial using the intertrial interval appropriate for that day. On the second day (Exp. I) the list was recalled and relearned. Immediately after relearning, the second experimental list was learned. This second experimental list was in turn recalled and relearned the following day, etc. The procedure was exactly the same for Exp. II except that 48 hr. elapsed between each session.

Each experiment had three conditions. Within each experiment both lists and intertrial rest conditions were completely counterbalanced against practice by using 36 *Ss*. The method for statistical analysis of such designs has been discussed by Archer (1). All *Ss* were undergraduate students.

Results

Practice day.—Since some direct comparisons between the two experiments will be made, it is necessary to demonstrate that performance of the two groups of *Ss* did not differ significantly on the practice list. The mean number of trials required to learn the practice list by *Ss* in Exp. I was 29.58, and for those in Exp. II, 28.22. The corresponding mean number of errors per trial was 1.38 and 1.41. For both trials and errors the within-group variance is greater than that between groups. The product-moment correlation between trials to learn the practice list and trials to learn all experimental lists combined for all 72 *Ss* was .58 ± .12. The value for errors was .66 ± .12.

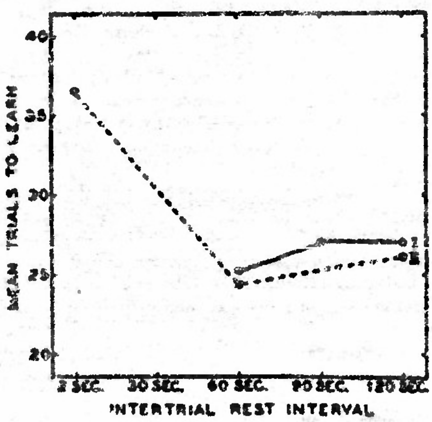

FIG. 1. Learning of serial nonsense lists as a function of intertrial interval

Learning.—The mean number of trials to learn under the different intertrial rest conditions is shown in Fig. 1. It may first be noted that in Exp. II distributed practice (as defined by 60- and 120-sec. rests) markedly facilitated learning as compared with massing (2-sec. rest). Secondly, it is observed that there is very little change in number of trials to learn between 60 and 120 sec. for either experiment. For Exp. I, *F* for trials to learn is less than one.

In the previous experiment (5) we used intertrial rest conditions of 2, 30, and 60 sec. and the same lists as used in the present experiments. Comparing the 2-sec. condition of the previous experiment and that of Exp. II shows the means are quite comparable. However, the mean trials to learn on the 60-sec. condition of the previous experiment (30.5) and on the 60-sec. conditions for the present two experiments (25.22 and 24.61) are quite diverse. The reason for this appears to lie in the selection of *Ss* which occurred in the present experiments. In these experiments the learning session was quite long even for an average *S* when the 2-min. distributed condition was used. A slow learner, requiring 40 trials to learn, would be in the experimental room about 1 hr. and 40 min. Consequently, we lost many *Ss* who were

TABLE 1

RETENTION OF SERIAL NONSENSE LISTS AS A FUNCTION OF INTERTRIAL INTERVAL DURING LEARNING*

Experiment	Intertrial Interval (Sec.)					σ_m	F
	2	30	60	90	120		
First Recall Trial							
I			4.28	5.28	4.72	.40	1.59
1952 (5)	7.72	4.08	4.36			.36	5.81
II	2.92		2.67		2.39	.33	.65
First and Second Recall Trials Combined							
I			9.94	12.06	11.03	.65	2.63
1952 (5)	13.64	9.94	10.28			.61	11.22
II	9.42		8.39		6.86	.60	4.60

* The scores are mean number of items recalled on first recall trial and on first and second recall trials combined. The estimate of σ_m is based on pooled *Ss* × practice variance. There are 2 and 66 *df* for each row; *F* at .05 level is 3.14; at .01, 4.95.

unable to complete the learning under the longer distribution intervals. The *Ss* we retained would be those most benefited by distributed practice, for these *Ss* could learn with a 2-min. distribution interval within a reasonable period of time. Therefore, we would expect the time to learn under the distributed conditions would be less in the present experiments than in the former.

Recall.—The mean number of items correct on the first recall trial and the mean number correct on the first and second recall trials combined are shown in Table 1. The entry, "1952 (5)," refers to the previously reported experiment (5) in which intervals of 2, 30, and 60 sec. were used with retention taken after 24 hr. Comparison of the results of Exp. I with those of the previous experiment cannot be made with absolute confidence since we do not know what the effect of subject selection (discussed above) may have on recall. It is apparent from Table 1, however, that recall following learning with 60-sec. intertrial interval (a condition which both experiments have in common) is very nearly the same on both the first recall trial and the first and second recall trials combined.

The essential facts given in Table 1 may be summarized as follows:

1. Experiment I shows no difference in recall for intervals of from 60 to 120 sec., and in all conditions recall is less than for the massed condition of the previous experiment. There is, then, no evidence that the difference between Hovland's findings and our previous findings is to be attributed to differences in length of distribution interval. Distribution intervals up to 2 min. give no evidence that distributed practice gives better recall than massed practice; indeed, all the evidence suggests that under the conditions of our research retention is better following massing than following distribution.

2. In Exp. II, where recall took place after 48 hr., the trend is likewise toward higher recall after massed practice than after distributed practice. On the first recall trial many

zero scores were recorded. However, the differences on the first and second recall trial combined almost attains a .01 level of confidence. Thus, there is no evidence that longer retention intervals and longer distribution intervals will change the basic generalization that in serial learning of nonsense syllables retention is better following massed practice than following distributed practice.

Relearning.—The mean number of trials to relearn for Exp. I was 11.86, 11.00, and 11.67 for 60-, 90-, and 120-sec. intertrial rests, respectively. The *F* is far from significant. In Exp. II, on the other hand, the values were 10.75, 11.83, and 13.72 for the 2-, 60-, and 120-sec. conditions. *F* is 4.00, which is approximately the .02 level of confidence. The most rapid relearning occurred with massed practice as would be expected from the recall scores.

Discussion

In conformance with two previous studies (4, 5) we have found that retention of serial nonsense lists is better following massed practice than following distributed practice. The results of the present studies make it unlikely that the discrepancy between Hovland's (3) findings (better recall following distributed practice) and ours is to be attributed to differences in intertrial intervals defining distribution or to length of retention interval. Therefore, the question still remains as to what could produce such markedly different results.

Our guess at the present time is that the contradiction is an indirect product of level of practice of *Ss* used in Hovland's research as compared with ours. Hovland's *Ss* served in many conditions and were given several practice days before they learned the 11-item experimental lists. The rate of learning the experimental lists was roughly twice that of our *Ss*. We have summarized elsewhere (6) the fragmentary evidence which suggests that items reinforced (correctly anticipated) many times will be recalled better following massed practice than following distributed practice, while items reinforced a few times will be better recalled following distributed practice. Well-practiced *Ss* (as in Hovland's research) correctly anticipate most items only a small number of times, whereas poorly practiced *Ss* (as in our research) have many items which have been reinforced many times. We might therefore expect Hovland's research to show better retention following distributed practice and ours better retention following massed practice. We hope to undertake research to determine if these guesses have any validity.

Summary

Hovland has found that following learning of serial nonsense lists by massed and distributed practice, retention is better for items learned under distribution. In more recent studies we found quite the opposite. One possible source of the discrepancy was the length of interval defining distributed practice, Hovland having used 2 min. as compared with 1 min. in our studies. Another possible factor was length of retention interval, it being conceivable that length of retention interval and length of distribution interval jointly determine whether retention will be facilitated by massed or by distributed practice. Two experiments were performed, one using distribution intervals of 60, 90, and 120 sec. between each learning trial with retention measured after 24 hr., and the other using intertrial intervals of 2, 60, and 120 sec., and a retention interval of 48 hr. Learning was car-

ried to one perfect trial under all conditions. The results show:

1. Better learning by distributed practice than by massed, but no change in rate of learning between 60- and 120-sec. intertrial intervals.

2. Better retention following massed practice than following distributed practice; this was evident for both recall and relearning. Little difference in retention was observed for intervals between 60 and 120 sec.

3. There was no indication that differences in retention following massed and distributed practice would decrease for retention intervals longer than 48 hr.

It is concluded that the differences between Hovland's results and our previous findings cannot be accounted for on the basis of length of intertrial interval defining distribution. It is possible that the differences between the studies may result from the fact that Hovland's *Ss* were very highly practiced whereas ours were not.

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THE MEMORY EFFECT OF VISUAL PERCEPTION OF THREE-DIMENSIONAL FORM

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The kinetic depth effect that has been discussed in a preceding paper (2) enables monocular *Ss* to perceive three-dimensional form as directly as do persons with serviceable binocular vision by means of retinal disparity. Yet this effect alone does not, of course, solve the entire problem of the perception of solid form. Three-dimensional form is seen monocularly also when the observer does not move in relation to the object and it is also perceived in photographs and drawings. It has been mentioned in the preceding paper that an empiristic explanation of these cases of three-dimensional form perception becomes more feasible through the demonstration of the kinetic depth effect. This is so because no empiristic explanation can be termed successful until it is made clear how the original process or experience is brought about under whose influence current experience is supposed to occur. Prior to the demonstration of the kinetic depth effect (KDE) no process was known which could account in a satisfactory way for the "original" perception of three-dimensional form in monocular *Ss*.

Two different approaches have been made to explain the perception of three-dimensional form that occurs in the absence of retinal disparity or of other specific cues for visual depth. It has been proposed that three-dimensional forms are seen under these circumstances because the corresponding retinal patterns have the power to evoke them directly. Gibson (1), who holds such a view, believes that such retinal patterns have geometric characteristics which are specific stimuli for depth just as there are specific stimuli for color, pitch, etc. Many Gestalt psychologists believe that visual processes are spontaneously organized so that certain patterns of stimulation lead to three-dimensional forms and others to plane forms in perception and they have tried to formulate the principles which underlie such organization. When three-dimensional objects are seen as three-dimensional forms, it is due to the fact that their retinal projections have properties which favor organization as three-dimensional forms. The other approach is, of course, the empiristic one. It is believed that previous experiences can cause a present perception in three dimensions.

For a number of reasons, one of which—the nature of the KDE itself—will be discussed below, we came to believe that an influence of past experience plays an important role in the perception of three-dimensional form and set out to demonstrate such an effect in a stringent way. Such a demonstration requires that a retinal pattern, which at the outset is seen as a plane figure, gives rise under identical external conditions to the perception of a three-dimensional form after an intervening exposure of the same pattern given under conditions which cause it to be seen as three-dimensional.

Method

There are several ways in which a pattern can be made to appear as a three-dimensional form in the intervening exposure. We found it most appropriate to use the KDE for this purpose, and